A330
TECHNICAL TRAINING MANUAL
MECHANICAL COURSE - T1 (LVL 2&3) (GE CF6)
FUEL INERTING

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FUEL INERTING

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FUEL TANK INERTING SYSTEM D/O (3)

INTRODUCTION

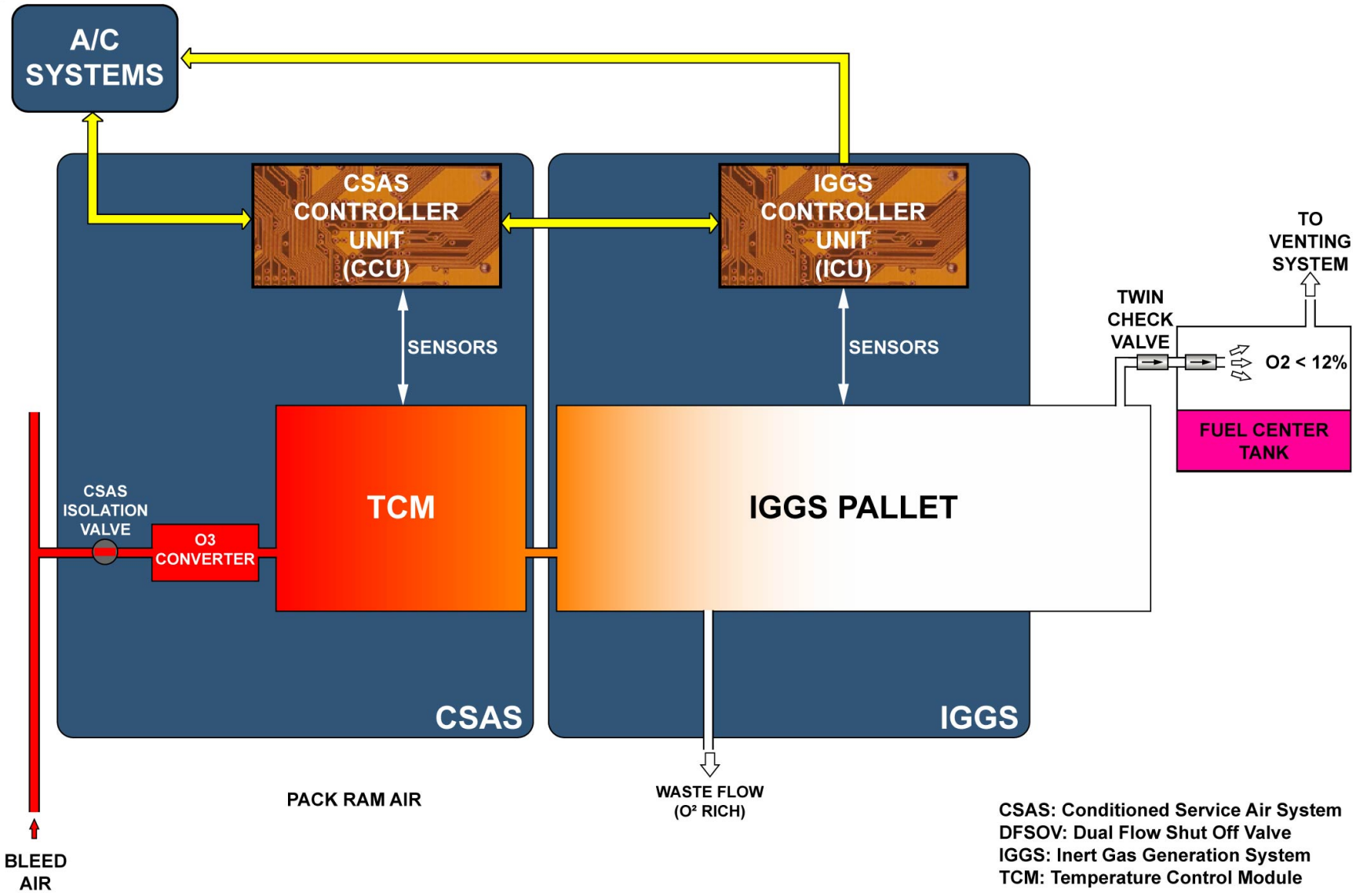
The Fuel Tank Inerting System (FTIS) is a Flammability Reduction Means to decrease the risk of fire and explosion in the fuel center tank. To do this, the FTIS causes inert conditions in the tank. The air is made up of 78% nitrogen, 21% oxygen and 1% other gases.
The fuel tank is inert when the average oxygen concentration:
- is less than 12% from sea level to a maximum altitude of 3048 m,
- is between 12% at 3048 m and 14.5% at 12192 m,
- decreases linearly for altitudes above 12192 m.

The FTIS operates automatically when these conditions occurs:
- Bleed air is available from ENG 1, ENG 2 or the two engines.
- Weight On Wheels (WOW) is not sensed: NLG not compressed.
- Environmental Control System (ECS) in operation.
- IGGS Latch status: not latched.
- The temperature of the air stream that goes into the IGGS is less than 47°C (116.60°F).
- No ENG 1 FIRE condition.

The FTIS has three Nitrogen Enriched Air (NEA) modes:
- Low Flow, during the climb and cruise phases, with the lowest oxygen levels and the highest nitrogen level to the fuel tank,
- Mid Flow, during the approach phase to keep the bleed air during the slow descent phase,
- High Flow, during the usual descent phase, because of the higher oxygen level in the ambient air that goes into the fuel tank through the vent system.

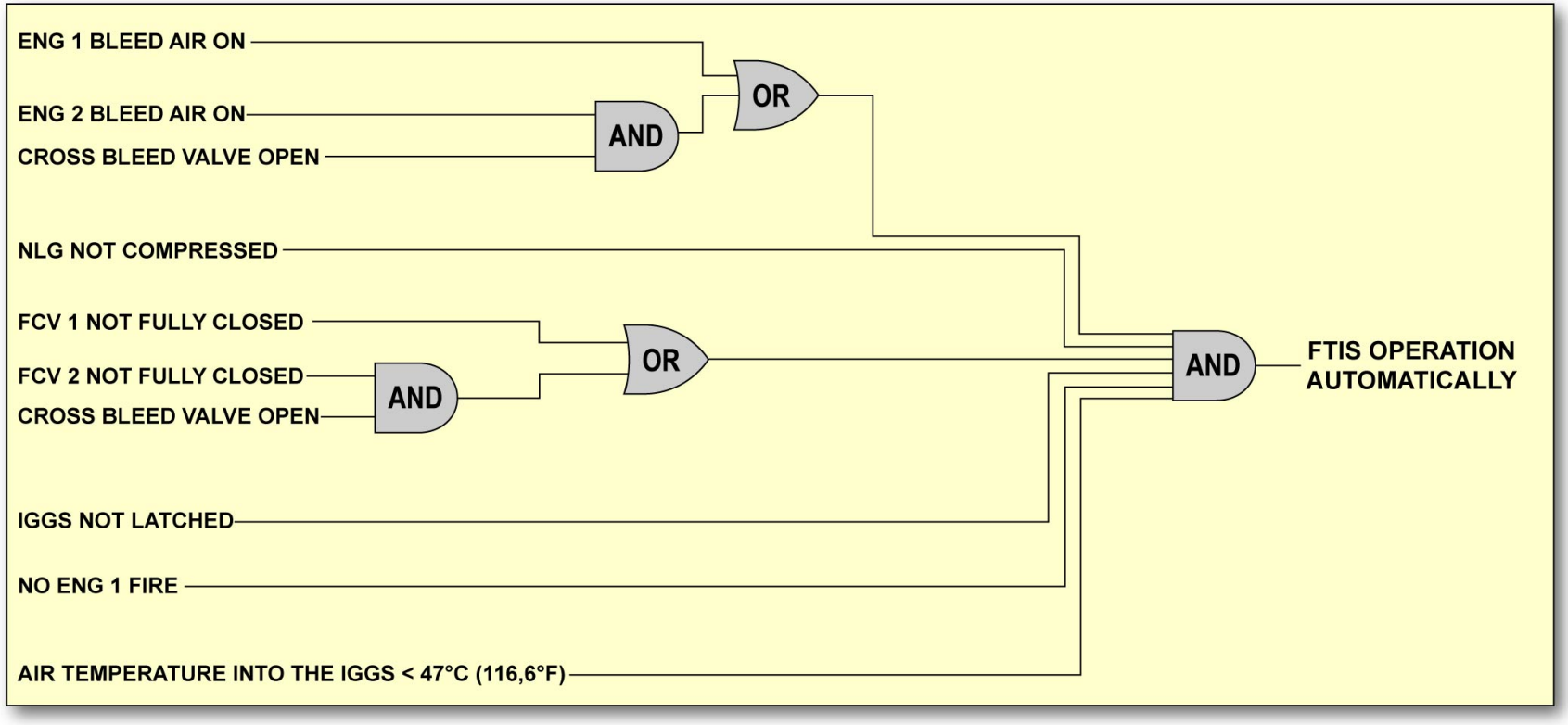
The FTIS includes two sub-systems:
- the Conditioned Service Air System (CSAS) that includes the Temperature Control Module (TCM) - ATA 21-58,
- the Inert Gas Generation System (IGGS) that includes the Inert Gas Distribution System (IGDS) - ATA 47-00.

The CSAS supplies the IGGS with air at the correct temperature, pressure and flow.
The IGGS removes the Oxygen Enriched Air (OEA) from the air flow and sends it overboard. The IGGS makes Nitrogen Enriched Air (NEA) which is sent into the fuel tank.
The CSAS Controller Unit (CCU) and the IGGS Controller Unit (ICU) control the FTIS automatically. The aircraft crew does not operate the FTIS.



INTRODUCTION

FUEL TANK INERTING SYSTEM OPERATION



INTRODUCTION

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CONDITIONED SERVICE AIR SYSTEM D/O (3)

CSAS DESCRIPTION AND OPERATION

The CSAS includes the components that follow:
- The Conditioned service air system Controller Unit (CCU) does the system control and health monitoring BITE and has interfaces with the aircraft computers (FWS, CMS, SDAC) and system (ENG1 Fire Push-button).
- The CSAS isolation valve gives protection to the system if the pressure is too low or too high or if the temperature is too high
- The Temperature Control Module (TCM) supplies a temperature of 60°C +/-6°C.

The CSAS controller controls the FTIS system, operates the valves and monitors the air temperature and air pressure.
The CSAS operates only during flight conditions.
During operation, the CSAS receives bleed air from the pneumatic air distribution system.
The APU or a Ground Cart supply can be used for test on Ground.

CSAS ISOLATION VALVE

The CSAS isolation valve is a solenoid-controlled, pneumatically operated butterfly valve. It controls the airflow in the TCM.
When there is no bleed air pressure or no electrical power, the CSAS isolation valve closes automatically and stops the system.

OZONE CONVERTER

The ozone converter is installed between the CSAS Isolation Valve and the Heat Exchanger. It uses a catalytic process to decrease the ozone concentration of the airflow and thus gives protection to the Air Separation Module (ASM) fibers.

TEMPERATURE AND PRESSURE CONTROL

The air temperature is controlled by the Temperature Control Module (TCM), which includes:
- a CSAS heat exchanger,
- a hot air bypass valve,
- a Temperature sensor,
- a CSAS Outlet Pressure Sensor.

CSAS HEAT EXCHANGER

The CSAS heat exchanger is installed in the ram air channel, upstream of the Pack 1 heat exchanger.

HOT AIR BYPASS VALVE

The hot air bypass valve adds hot air to the cold air, downstream of the heat exchanger, to adjust the temperature.
The hot air bypass valve actuator is a stepper motor that moves a butterfly type valve from its open to its closed position.
The CSAS controller operates the hot air bypass valve.

TEMPERATURE SENSOR

A dual element temperature sensor monitors the temperature of the conditioned air in the duct before it flows to the Inert Gas Generation System. The temperature sensor transmits this data to the CSAS controller.

CSAS OUTLET PRESSURE SENSOR

A pressure sensor monitors the pressure of the conditioned air in the duct before it flows to the Inert Gas Generation System.
The pressure sensor is installed between the temperature sensor and the inlet of the inert gas generation system.
The sensor transmits this data to the CSAS controller.

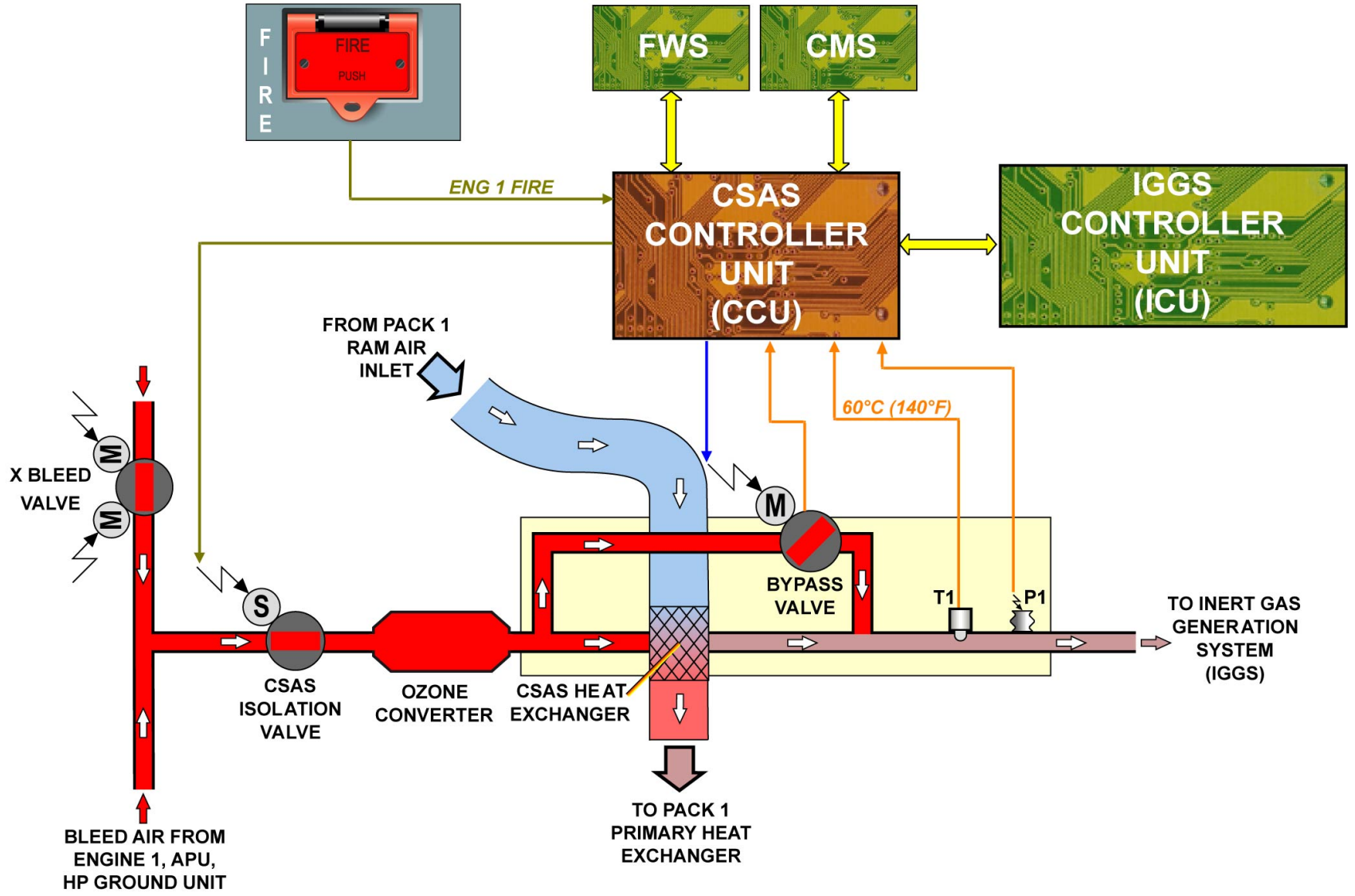
ABNORMAL PROCEDURES

If the pressure or the temperature is too high, the CSAS isolation valve closes to stop the system.

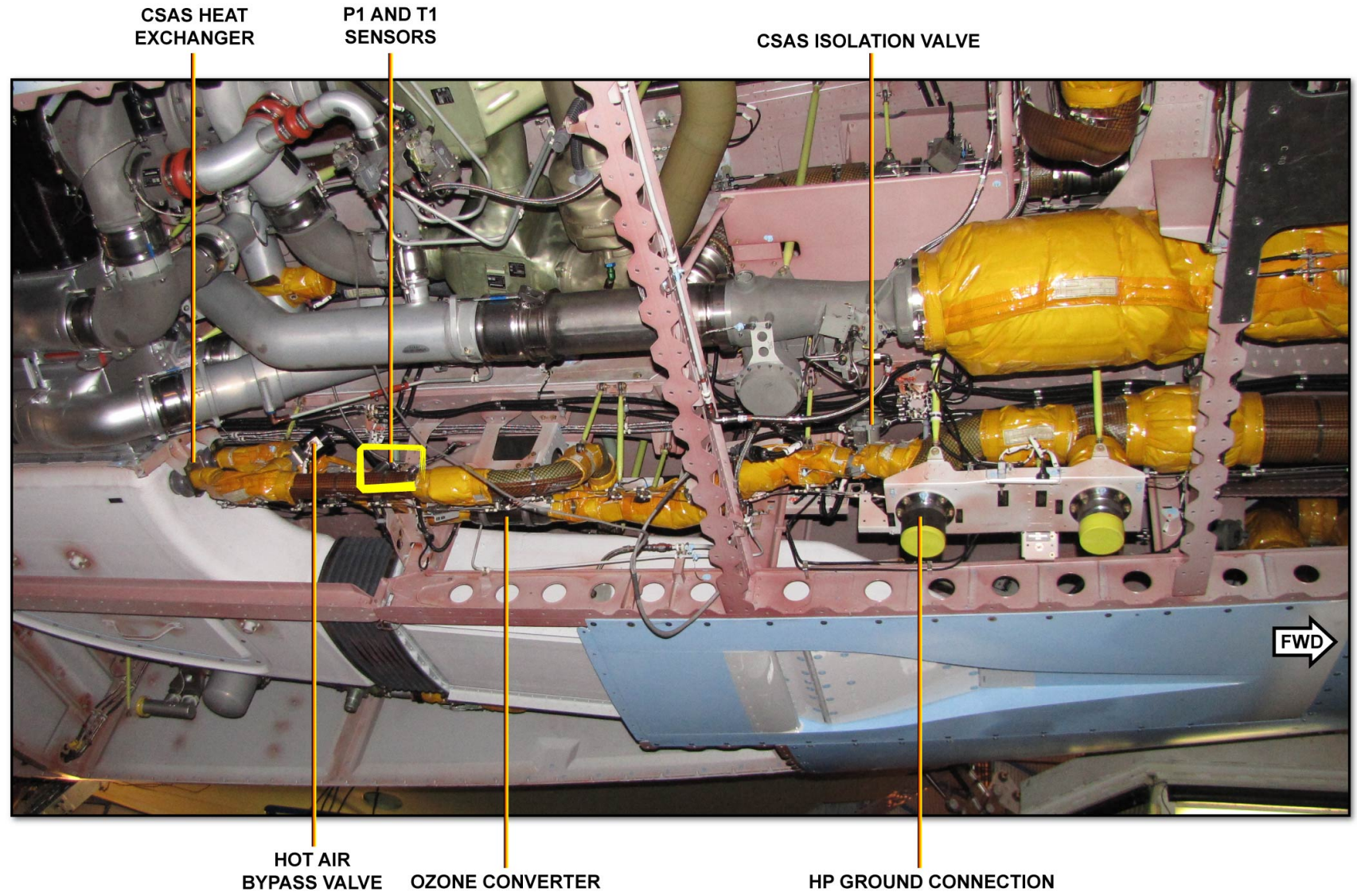
MAINTENANCE OPERATION

There are two interactive BITE test modes:
- System test without bleed air: this test is used to do a check of the electrical integrity of the system. To do this, signals are sent to or received from the different components.
- System test with bleed air: this test is used to do a check of the electrical integrity of the system and a check of the behavior of the valves at low, middle and high flows.

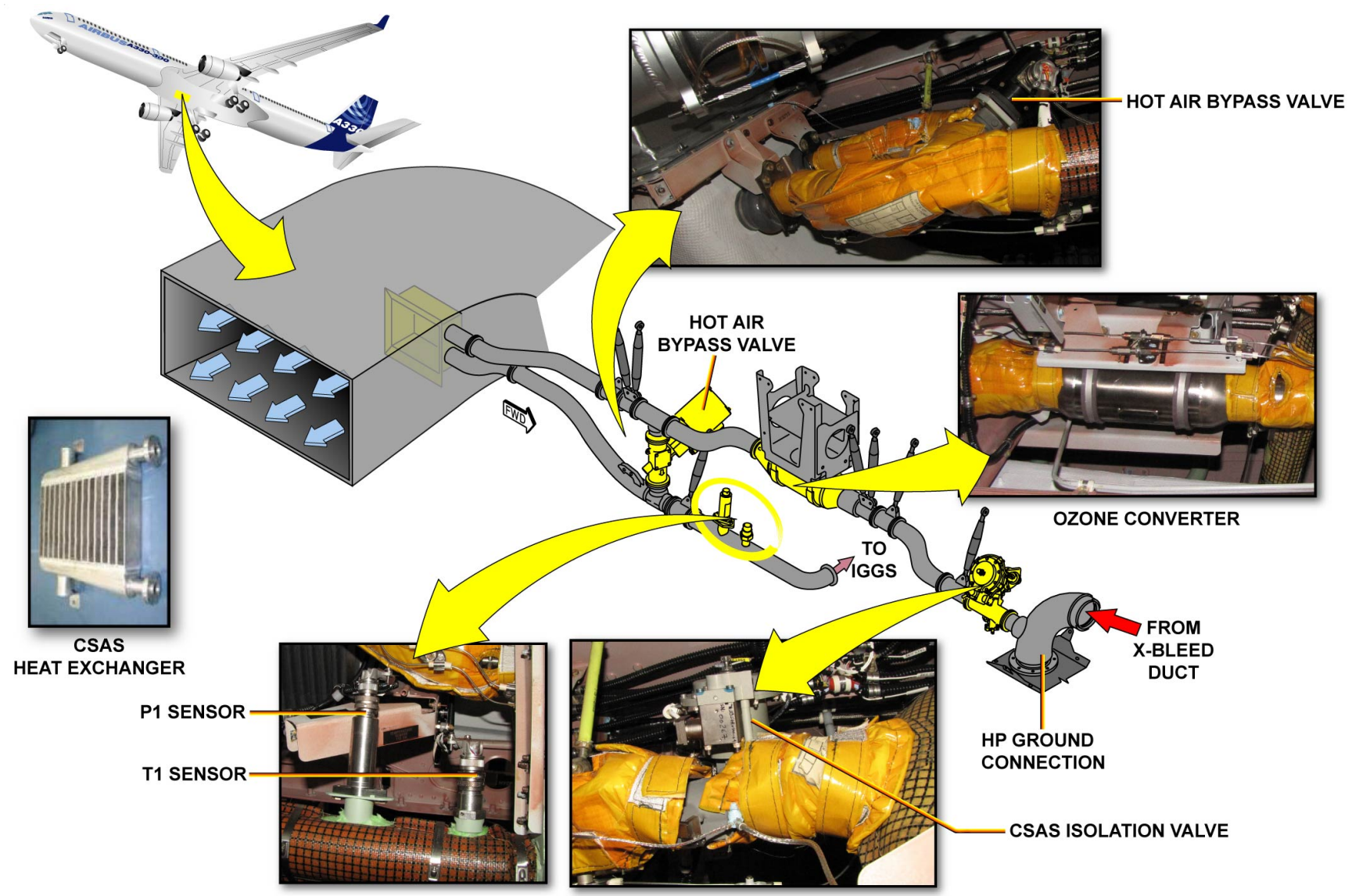
The initial conditions are:
- Auxiliary Power Unit (APU) or ground supply,
- Pack1 ON and Pack2 OFF,
- Cross-bleed valve closed.



CSAS DESCRIPTION AND OPERATION ... MAINTENANCE OPERATION



CSAS DESCRIPTION AND OPERATION ... MAINTENANCE OPERATION



CSAS DESCRIPTION AND OPERATION ... MAINTENANCE OPERATION

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INERT GAS GENERATION SYSTEM D/O (3)

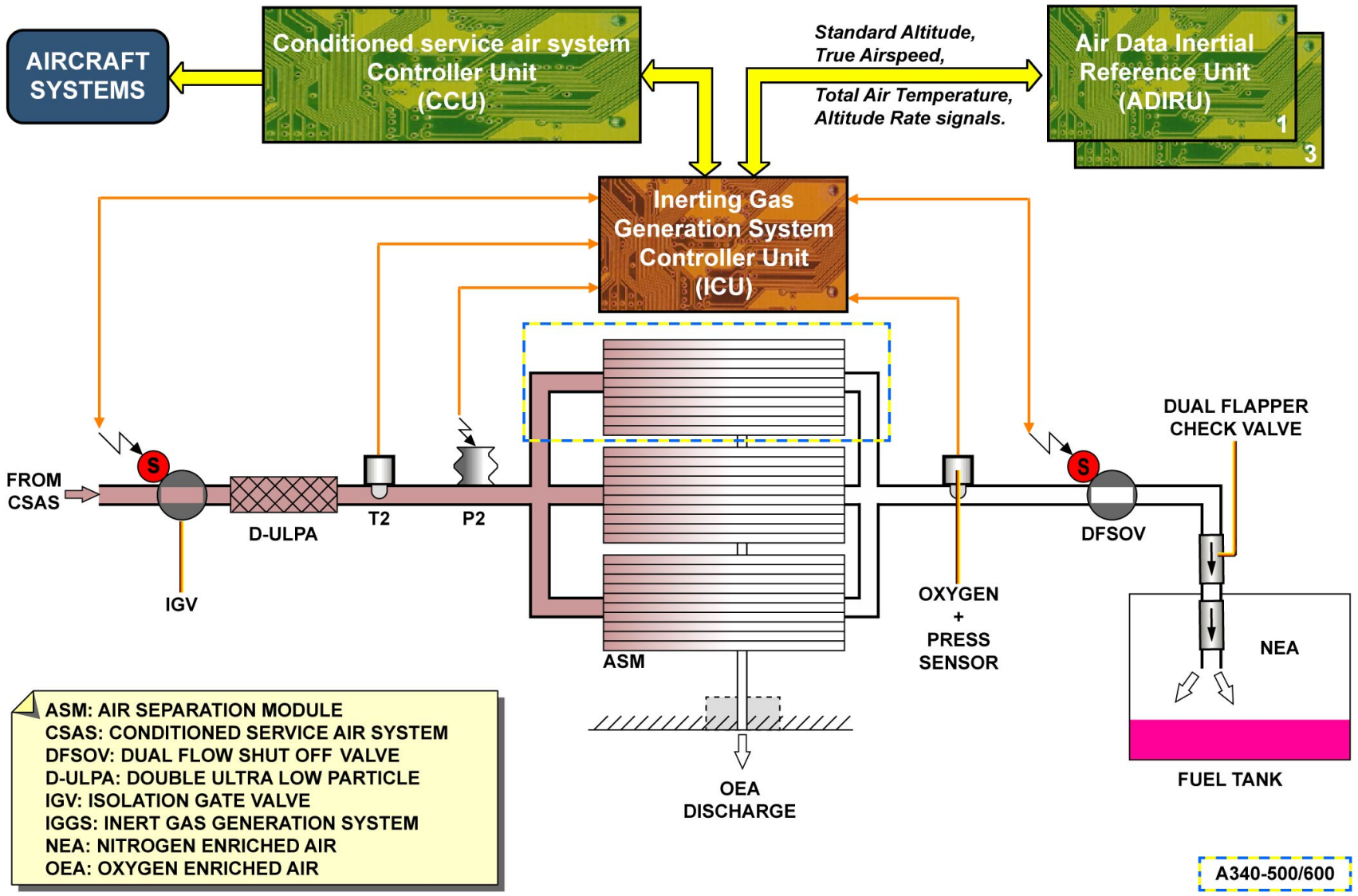
IGGS DESCRIPTION

The IGGS has the components that follow:
- The IGGS Controller Unit (ICU) supplies system health monitoring and BITE. The ICU uses an ARINC 429 bus for its communications with the CSAS Controller Unit (CCU), the Air Data/Inertial Reference Units (ADIRU1&3) and the Centralized Maintenance System (CMS),.
- The Double-Ultra Low Particle Air (D-ULPA) Filter cleans the air that goes into the Air Separator Modules.
- Two Air Separation Modules (ASM) are used for the separation of Nitrogen and Oxygen.

The Inert Gas Distribution System (IGDS) supplies the NEA from the IGGS to the fuel tank and prevents fuel ingress from the fuel tank back to the IGGS.
The IGDS has the components that follow:
- an Isolation Gate Valve (GV),
- a Dual Flow and Shut-Off Valve (DFSOV),
- a Dual-Flapper Check Valve,
- an In-Tank Housing.

The Inert Gas Indicating System (IGIS) supplies the IGGS Controller Unit with temperature, pressure and oxygen concentration from the components that follow:
- a Temperature Sensor,
- a Pressure Sensor,
- an Oxygen Sensor related to a pressure sensor.

The IGGS components are installed on an IGGS Pallet that will be installed on aircraft as a complete assembly. But the ICU, the Dual Flapper Check Valve and the In-tank Housing are not installed on an IGGS pallet.
The IGGS Controller Unit (ICU) controls the system and uses the ARINC 429 protocol for its communications with the CSAS Controller Unit (CCU) and the Air Data/Inertial Reference Unit 1&3 (ADIRU1&3).



IGGS DESCRIPTION

INERT GAS GENERATION SYSTEM D/O (3)

IGGS COMPONENTS DESCRIPTION AND OPERATION

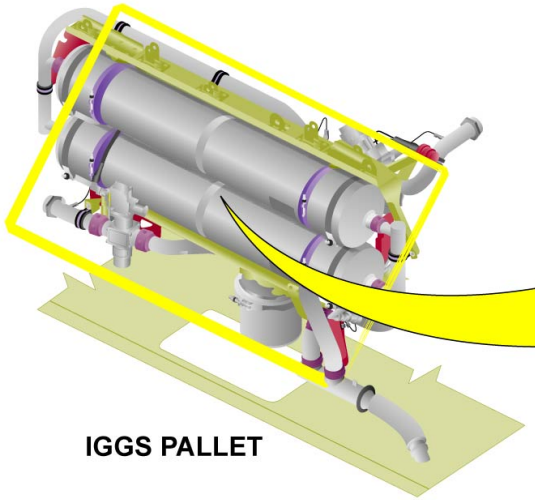
ISOLATION GATE VALVE (IGV)

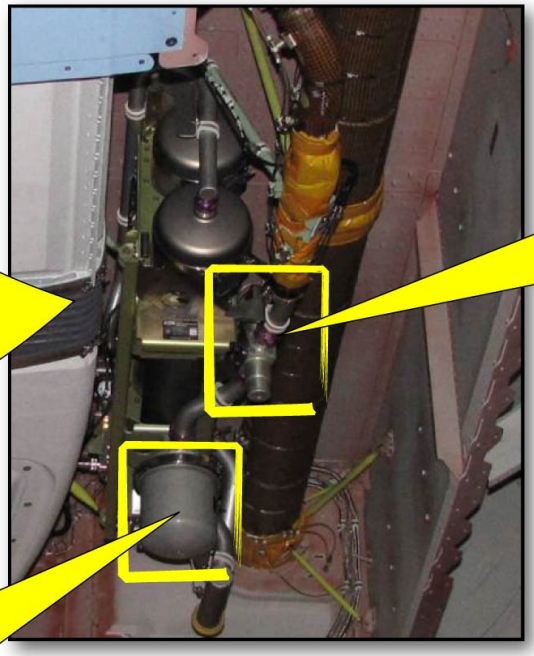
The Isolation Gate Valve is an electro pneumatic valve installed downstream of the IGGS pallet inlet and upstream of the filter.
The IGV prevents contact of hot air with fuel or fuel vapor if the CSAS is too hot.
The IGV is controlled to close in the conditions that follow:
- The temperature sensed by the IGGS temperature sensor T2, upstream of the ASM, is too high (temp > 85°C).
- The pressure sensed by the IGGS pressure sensor P2, upstream of the ASM, is too low (pressure < 15 psig).
- A CSAS controller signal causes the shutdown of the FTIS.

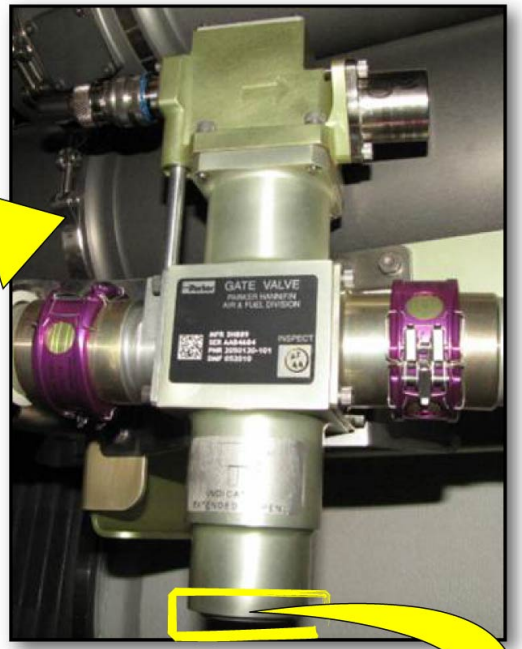
The IGV has a closed-position indication switch that gives input to the IGGS Controller Unit for monitoring and fault detection.
It also has a mechanical visual indicator (pop-out) used for the troubleshooting.

D-ULPA FILTER

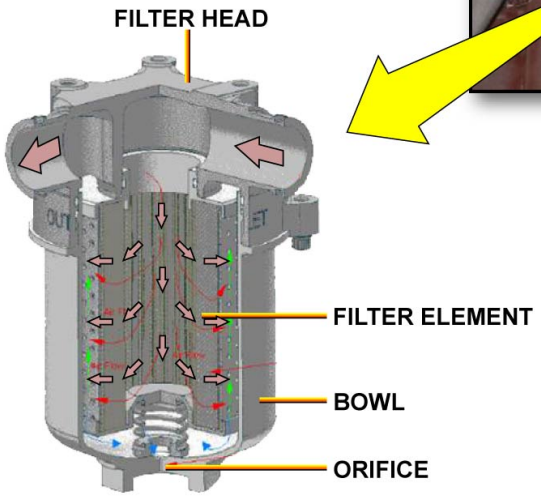
The bleed air that comes from the CSAS goes through the D-ULPA filter. This filter removes the hydrocarbons and dust from the bleed air before the air goes into the ASM.
Downstream of the D-ULPA filter, a temperature sensor T2 and a pressure sensor P2 send the airflow parameters to the ICU.


IGGS PALLET


IGGS PALLET



ISOLATION GATE VALVE (IGV)



D-ULPA FILTER

POP OUT POSITION INDICATOR

IGGS COMPONENTS DESCRIPTION AND OPERATION - ISOLATION GATE VALVE (IGV) & D-ULPA FILTER

INERT GAS GENERATION SYSTEM D/O (3)

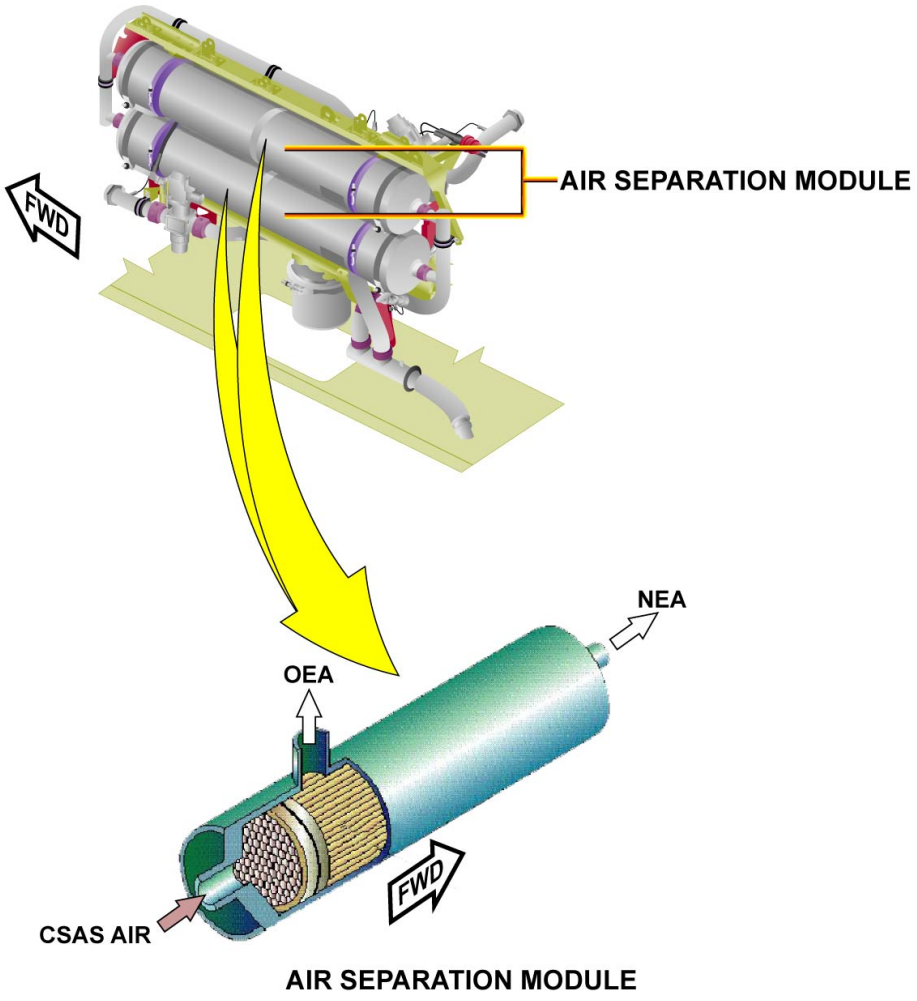
IGGS COMPONENTS DESCRIPTION AND OPERATION (continued)

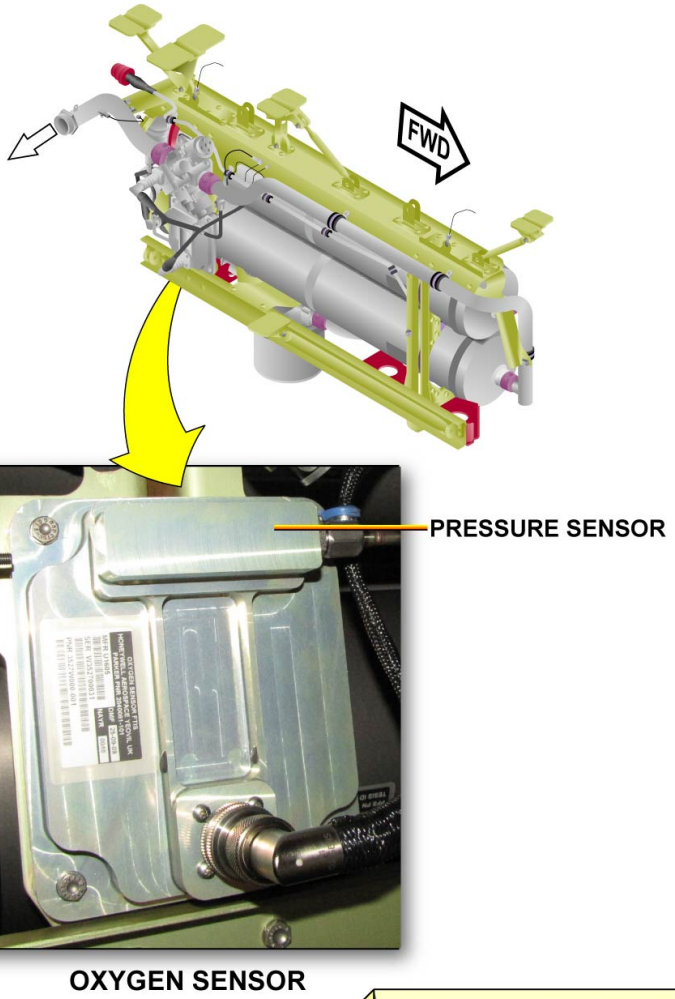
AIR SEPARATION MODULE (ASM)

The IGGS Pallet has 2 ASMs (3 ASMs on A340-500/600).
The ASM, which is the core of the IGGS, removes the oxygen from the air flow and sends the NEA to the fuel center tank. The OEA is sent overboard through an outlet.
The Air Separator Modules (ASM) have two pressure containment canisters that contain a bundle made of hundreds of thousands of hollow fibers with semi-permeable membrane and of very small diameter.
The ASM inlet temperature is 60 °C with an overheat threshold of 85°C (185°F).
The ASM inlet pressure can change between 20 and 60 psi.

OXYGEN SENSOR

One time during each flight, during the health-monitoring interval, the O2 sensor monitors the oxygen concentration in the NEA flow, downstream of the ASM.
The ICU uses the oxygen concentration data to calculate the FTIS general performance.
The oxygen sensor measures the oxygen rate to prevent a high oxygen concentration in the fuel center tank.
The oxygen sensor has a pressure sensing capability. It sense and prevents an over-pressure build-up in the center tank.
Oxygen sensor Monitoring:
The ICU monitors the oxygen sensor one time during each flight. An FTIS shutdown will not occur.
Steady state flight conditions are necessary for a minimum of 9 minutes 45 sec in cruise to complete the test.
If the steady state is not completed, an unsatisfactory Health Monitoring Test is recorded. When 8 Health Monitoring Tests are done one after the other with unsatisfactory results, a fault message is sent.





NOTE: A340-500/600 FTIS INCLUSED 3 ASM's

OEA: Oxygen Enriched Air
NEA: Nitrogen Enriched Air

IGGS COMPONENTS DESCRIPTION AND OPERATION - AIR SEPARATION MODULE (ASM) & OXYGEN SENSOR

INERT GAS GENERATION SYSTEM D/O (3)

IGGS COMPONENTS DESCRIPTION AND OPERATION (continued)

DUAL FLOW SHUT OFF VALVE

The DFSOV uses two solenoid-operated poppets to supply the applicable NEA flow to the fuel center tank. The IGGS Controller Unit supplies 28VDC to the two DFSOV solenoids to set the DFSOV to the applicable flow position. This position changes for the different A/C flight phases.

The DFSOV sets the NEA to high flow during descent, mid flow during approach, low flow during climb or cruise, and no flow or off when the aircraft is on the ground.

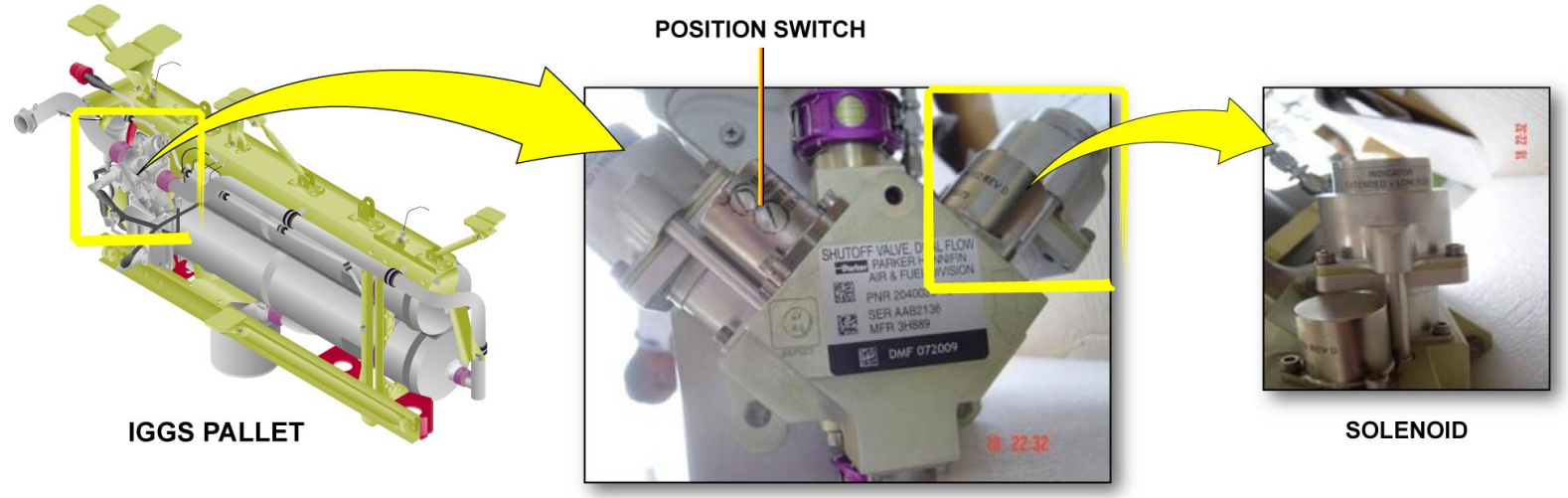
The DFSOV is normally closed (solenoids not energized) when the FTIS does not operate. The valve is designed to be failsafe in the closed position. Thus the valve is normally closed when there is a low upstream pressure (20psig maximum) or a solenoid failure.

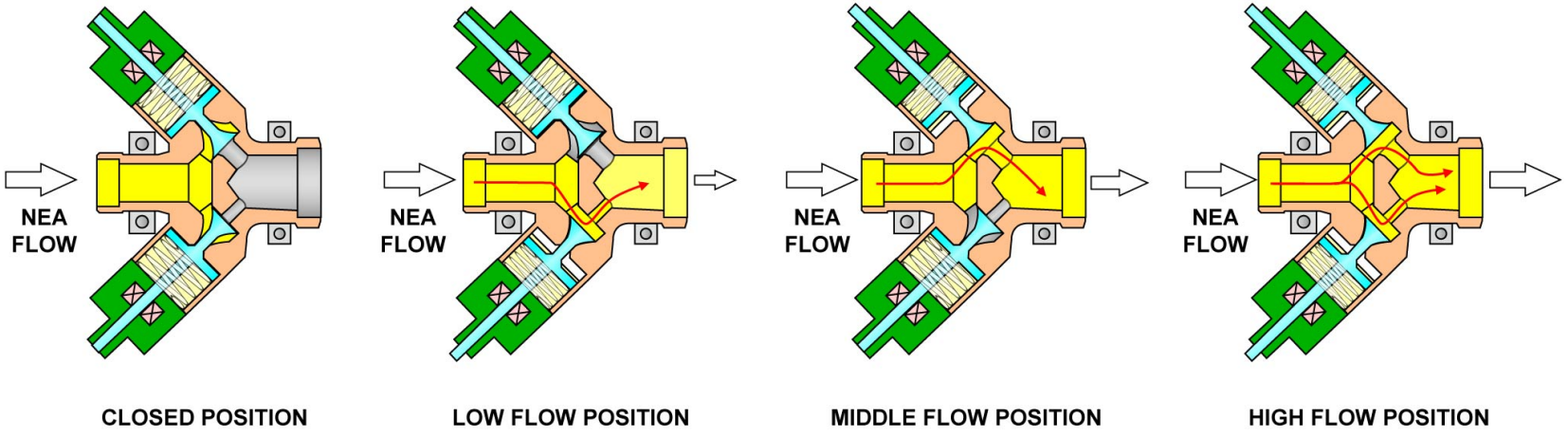
The valve has switches that show the fully-closed/not fully-closed position (one switch for each poppet). The switches are used by the IGGS controller to monitor the DFSOV operation for system monitoring and fault detection.

The valve also has a mechanical visual position indicator on each poppet for line maintenance troubleshooting.

If an abnormal situation occurs, the DFSOV is used to isolate the IGGS from the center fuel tank if:

- the ASM inlet pressure P2 is less than 15 psi (1.0342 bar),
- and/or the ASM inlet temperature T2 is higher than 85°C (185.00 deg.F).





IGGS COMPONENTS DESCRIPTION AND OPERATION - DUAL FLOW SHUT OFF VALVE

INERT GAS GENERATION SYSTEM D/O (3)

IGGS COMPONENTS DESCRIPTION AND OPERATION (continued)

DUAL FLAPPER CHECK VALVE

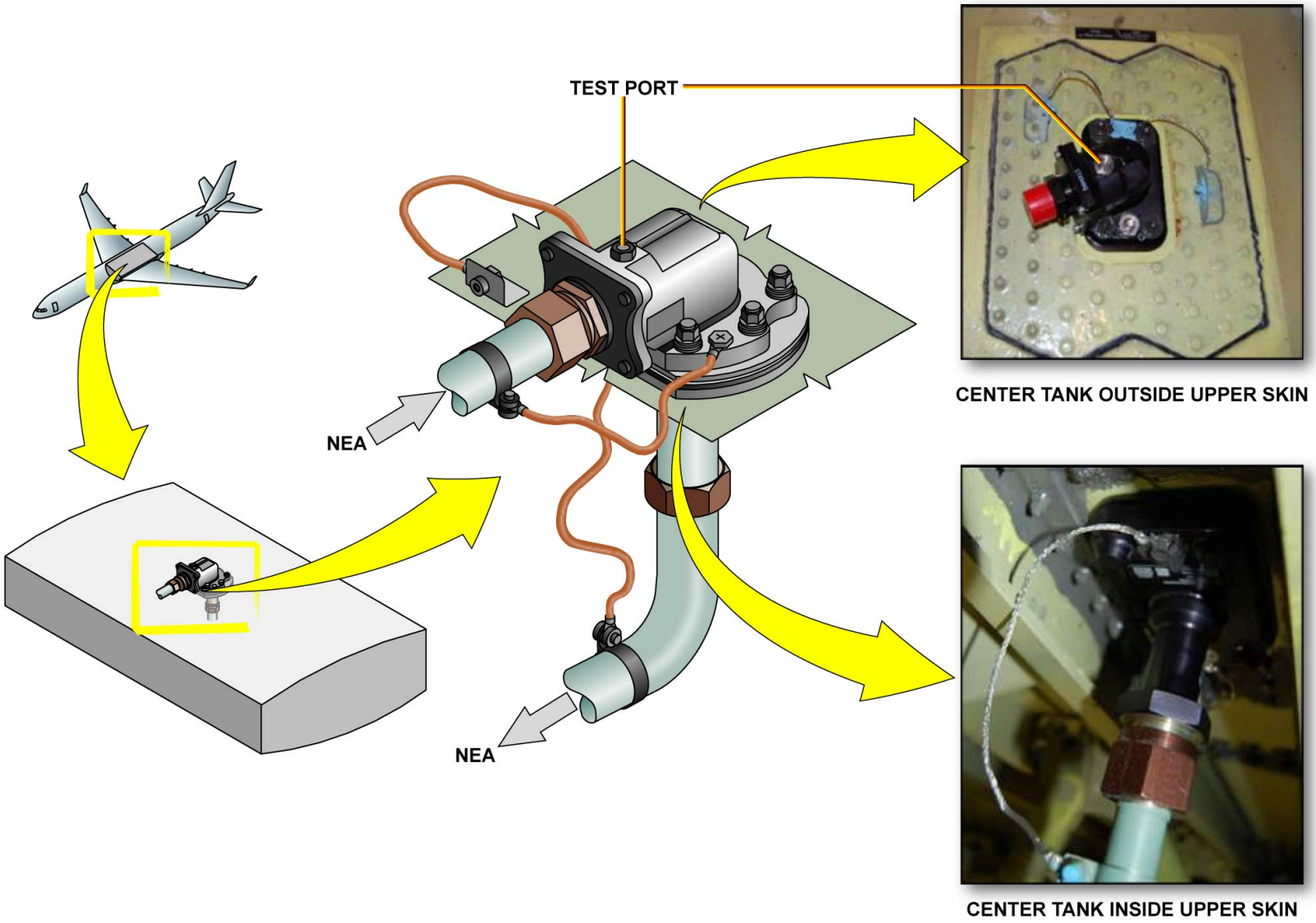
A Dual Flapper Check Valve makes a double barrier to prevent fuel ingress from the fuel tank back to the IGGS and prevent fuel leakage out of the tank.

The valve includes two in-line flapper type check valves (Dual flapper check valves) installed on the outer side of the fuel tank wall.

The Dual Flapper Check Valve (DFCV) is installed on top of the center tank.

The In-Tank Housing (ITH) is installed in the center tank, immediately below the DFCV. This is a second protection that stops the NEA flow and prevents fuel leakage.

You can do the Dual Flapper Check Valve test to do a check of the pressure drop. This pressure drop can show a leak path in the DFCV and the upper center tank double skin panel. The test is correct if there is no pressure drop. A Test set tool and a DFCV test port adaptor are necessary to do the test (see AMM).



IGGS COMPONENTS DESCRIPTION AND OPERATION - DUAL FLAPPER CHECK VALVE

INERT GAS GENERATION SYSTEM D/O (3)

IGGS COMPONENTS DESCRIPTION AND OPERATION (continued)

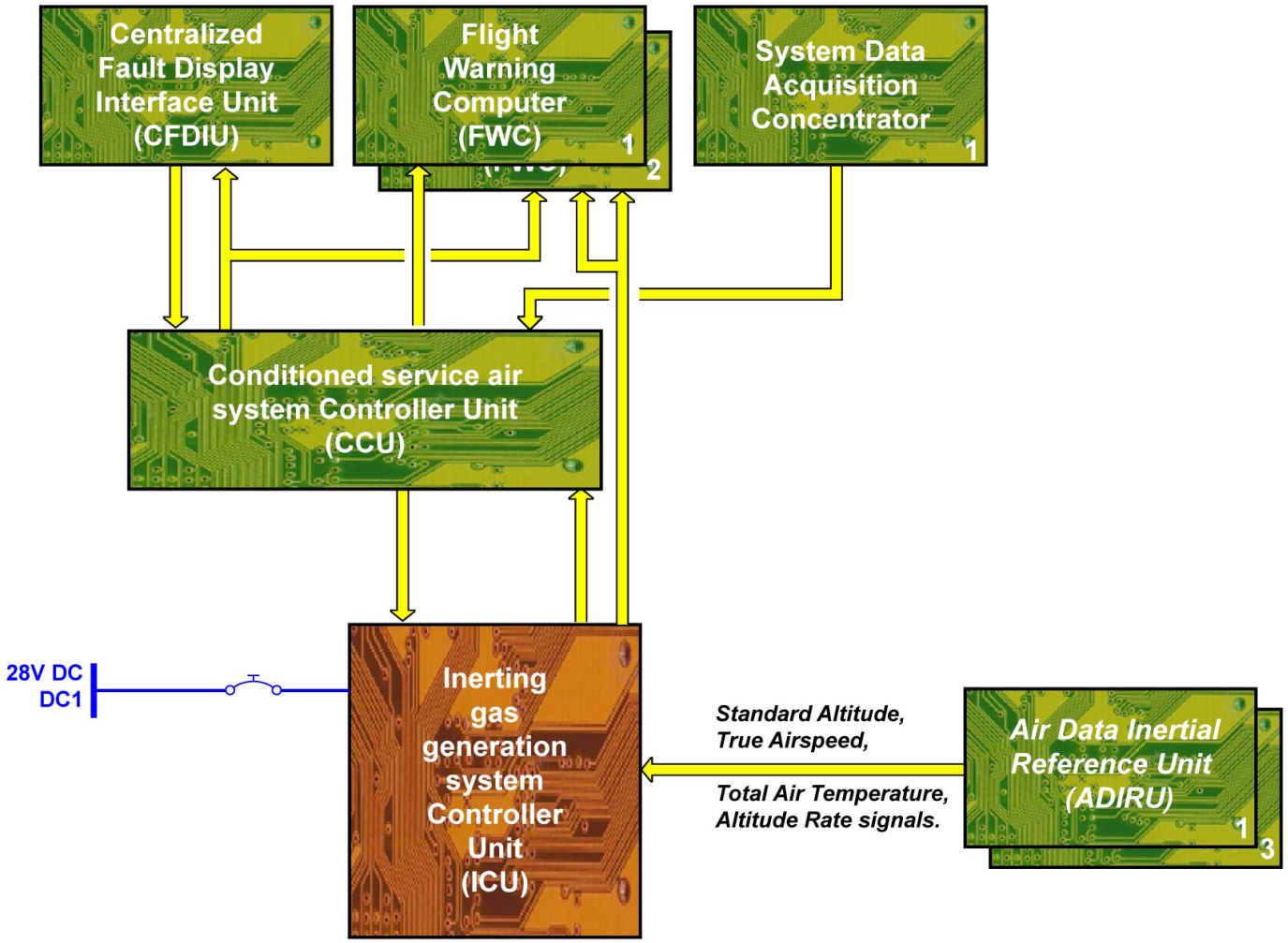
IGGS CONTROLLER UNIT (ICU)

The ICU functions are:
- to monitor the health of the IGGS equipment, but not of the Dual-Flapper Check Valve (DFCV),
- to set the Nitrogen Enriched Air (NEA) flow mode (low, high or middle),
- to give protection from temperatures too high,
- to give protection from pressures too high and too low,
- to send the IGGS condition reports to the CSAS,
- to do the power-up BITE Test,
- to do the BITE for the IGGS electrical and electronic equipment,
- to do a check of the oxygen sensor status (one time during cruise phase),
- to monitor the Air Separator Modules (ASM) status (O2 sensor check result).

The ICU uses an ARINC signal for its communications with the CCU for condition monitoring and analog input/output signals from/to the sensors for operation. The ICU receives the Standard Altitude, True Airspeed, Total Air Temperature and Altitude Rate signals from the ADIRU 1&3.

The ICU has interfaces with the Fuel Control and Monitoring Computers (FCMC 1&2).

The CCU is used as an interface between the ICU, the FWS and the CMS.



IGGS COMPONENTS DESCRIPTION AND OPERATION - IGGS CONTROLLER UNIT (ICU)

INERT GAS GENERATION SYSTEM D/O (3)

FTIS OPERATION

NORMAL OPERATION

The FTIS operates automatically when these conditions occur:
- Bleed air is available from ENG 1 ON or ENG 2 ON with the Cross Bleed valve open.
- The Weight On Wheels (WOW) is not sensed: NLG not compressed.
- The Environmental Control System (ECS) is in operation: Flow Control Valve 1 (FCV) is not Fully Closed, or FCV 2 is not Fully Closed and Cross Bleed Valve is open.
- The IGGS Latch status is not latched.
- The temperature of the air flow that goes into the IGGS is less than 47°C (116.60 °F).
- There is no ENG 1 FIRE condition.

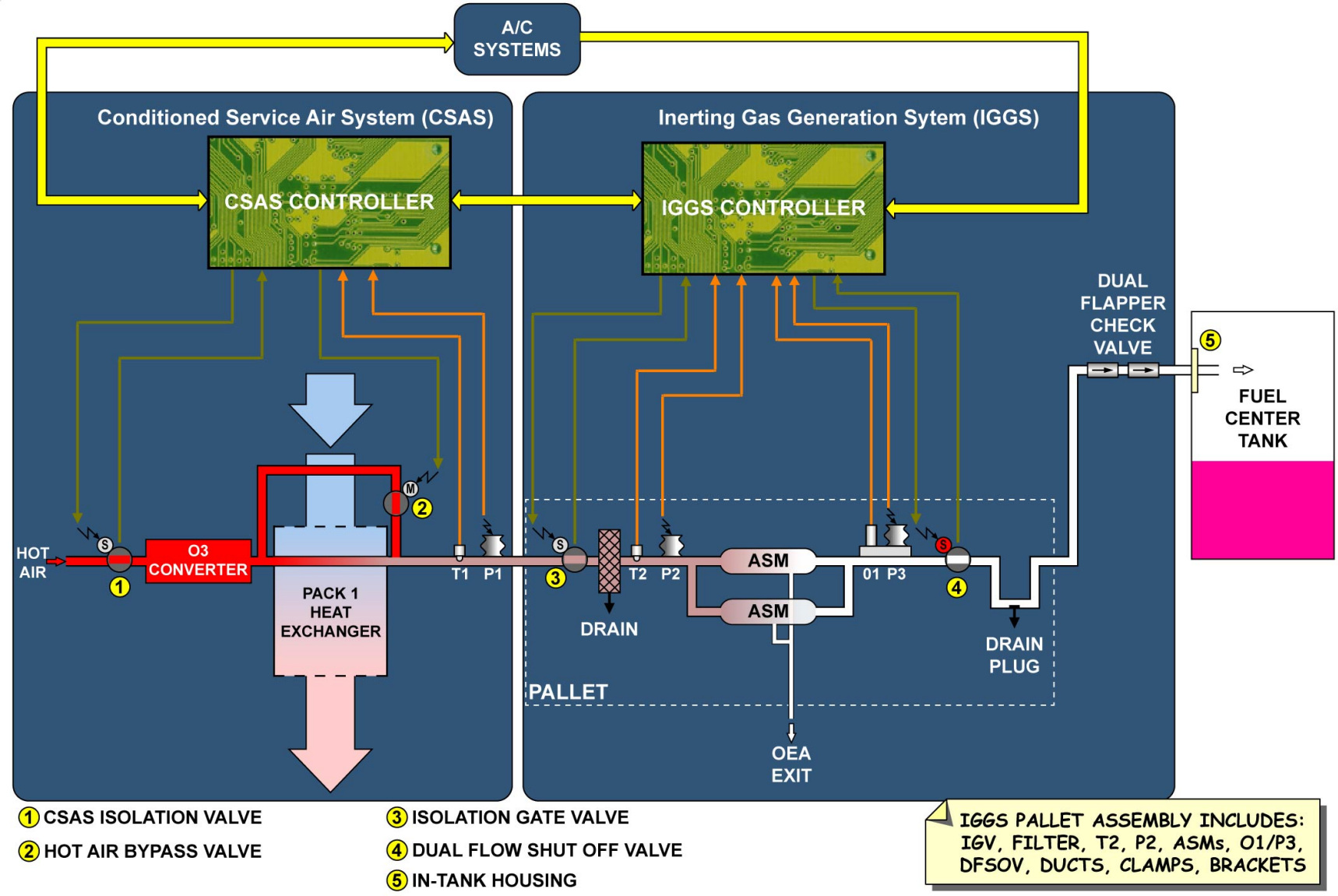
ABNORMAL OPERATION

When the ICU senses a fault, it sends a signal to the CCU, which then sends a signal to the Flight Warning Computers (FWC1 and FWC2). The CCU and ICU can each use the signals from their sensors to cause an FTIS shutdown.
If the pressure or the temperature is too high, the ICU de-energizes the solenoid to close the IGGS Isolation Gate Valve.
If the pressure is too low, the ICU de-energizes the solenoids to close the Dual Flow Shut Off Valve.
If the oxygen sensor senses an oxygen rate higher than 12%, the ICU de-energizes the solenoids to close the IGGS Isolation Gate Valves and the DFSOV.
If the ICU or the CCU senses a failure of the system or of the components above, it immediately causes a latch of the system and:
- the CIV, DFSOV & Isolation Gate Valve close automatically,
- a cockpit indication is shown during Flight Phase 1 or 10,
- a class 1 ECAM message FUEL INERTING SYS FAULT is sent. This message refers to MEL entry 47-10: FUEL INERTING SYS FAULT.

MAINTENANCE OPERATION

The CSAS has a normal mode (failure message transmission, BITE status transmission) and an interactive mode. With the interactive mode, you can:
- do a system test without bleed air,
- do a system test with bleed air,
- get troubleshooting data,
- get fault reports.

The FTIS deactivation is not possible.



FTIS OPERATION & MAINTENANCE OPERATION

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